(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
4 July 2002 (04.07.2002)

PCT

(10) International Publication Number
WO 02/051668 A1

(51) International Patent Classification[7]: B60R 16/02

(21) International Application Number: PCT/FI01/01144

(22) International Filing Date:
21 December 2001 (21.12.2001)

(25) Filing Language: Finnish

(26) Publication Language: English

(30) Priority Data:
20002834 22 December 2000 (22.12.2000) FI

(71) Applicant *(for all designated States except US)*: **IWS INTERNATIONAL OY** [FI/FI]; Posantie 10, FIN-90650 Oulu (FI).

(72) Inventors; and

(75) Inventors/Applicants *(for US only)*: **JUNTUNEN, Asko** [FI/FI]; Satulatie 21, FIN-90540 Oulu (FI). **LAMBERG, Lauri** [FI/FI]; Uudenmaankatu 68 A 21, FIN-05830 Hyvinkää (FI).

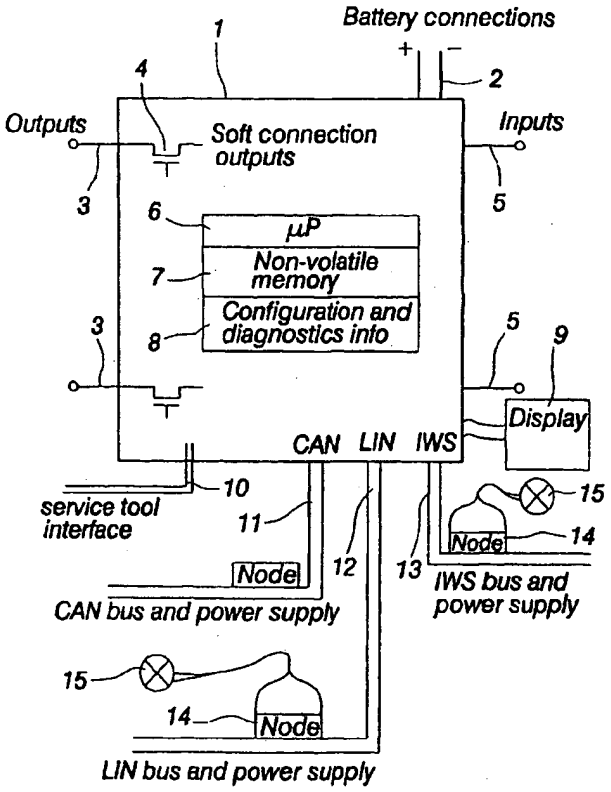
(74) Agent: **LEITZINGER OY**; Tammasaarenkatu 1, FIN-00180 Helsinki (FI).

(81) Designated States *(national)*: AE, AG, AL, AM, AT, AT (utility model), AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, CZ (utility model), DE, DE (utility model), DK, DK (utility model), DM, DZ, EC, EE, EE (utility model), ES, FI, FI (utility model), GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, OM, PH, PL, PT, RO, RU, SD, SE, SG, SI, SK, SK (utility model), SL, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VN, YU, ZA, ZM, ZW.

(84) Designated States *(regional)*: ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM),

[Continued on next page]

(54) Title: INTELLIGENT FUSE BOX FOR THE POWER DISTRIBUTION SYSTEM OF A VEHICLE



(57) Abstract: The present invention relates to intelligent fuse box (1) for a vehicle's multiplex power distribution system, the fuse box including outputs (3) for driving the vehicle's functional components/actuators and/or cable buses (11-13) equipped with intelligent_nodes (14), the latter in turn having outputs for driving functional components/actuators (15), and further including means serving fuse functions between the outputs (3; 11-13) and the vehicle'spower supply bus (12). The fuse-function means are controlled solid-state switches (4). The fuse box (1) includes inputs (5) for receiving messages controlling the ON/OFF state of solid-state switches (4) and a microprocessor (6), the latter controlling the solid-state switches (4) based on a program stored in the microprocessor memory (7) and on current limits predetermined in configuration data (8). In addition to the actual fuse functions,the controlled operation of the solid-state switches offer a plurality of auxiliary functions such as rush current limiting, programmable reconfiguration of current limits, dynamic fuse functions (e.g.,to implement a low-current Asleep mode in a parked vehicle) and measurement of system overall load current.

WO 02/051668 A1

European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

Published:

— *with international search report*

Intelligent fuse box for the power distribution system of a vehicle

The present invention relates to an intelligent fuse box for a vehicle's multiplex power distribution system, whereby the fuse box includes outputs for supplying the vehicle's functional components/actuators and/or cable buses equipped with intelligent nodes, that latter in turn having outputs for driving functional components/actuators, and further includes means serving fuse functions between the outputs and the vehicle's power supply bus.

Known from patent publication EP 529,650 is a vehicle's multiplex power distribution system, wherein the outgoing buses from the supply power distribution point to intelligent nodes are individually protected by fuses that provide protection against both overcurrent and short-circuit situations. These fuses are not implemented using solid-state switches.

Known from US Pat. No. 4,575,673 is a vehicle's multiplex power distribution system, whose intelligent nodes include electronic means for monitoring the load current and switching off the vehicle power to the load if a given reference current level is exceeded with a due margin in respect to inrush transients. Instead of being concentrated in a single fuse box of the system, the gated solid-state switches are incorporated in the control modules that are located in a distributed fashion. Hence, the system disclosed in US Pat. No. 4,575,673 needs a separate (conventional) fuse box between the vehicle power supply and the bus outputs for protecting the buses and the intelligent nodes located along the buses.

It is an object of the present invention to provide an intelligent fuse box of the above-described kind that is suited for use as an intermediate unit between the primary power supply and a vehicle's multiplex power distribution system.

Conventional fuse boxes are handicapped by plural problems such as:

- due to their mechanical or thermal trip function, the fuse elements cannot

be adjusted for different overcurrent levels,

- the fuse elements are of the slow-blow type, which inherently invokes a fire hazard in a short-circuit or overload situation,
- the trip levels of fuse elements are invariably nonprogrammable, whereby it is impossible to meet the need for reducing the trip level of a fuse element in an Asleep state, for instance, without manipulating the mechanical fuse elements,
- the fuse element cannot perform any interference filtration, and
- last but not least, the life of mechanically tripping protective elements is always limited.

These problems and limitations can be overcome by virtue of an intelligent fuse box according to the invention, whose characterizing features are specified in appended claim 1. Details of preferred embodiments of the invention are disclosed in the dependent claims.

In the following, the invention will be examined in greater detail with the help of an exemplary embodiment by making reference to the appended drawing illustrating an intelligent fuse box according to the invention in a block diagram.

As illustrated, a fuse box 1 provides outputs 3 for driving functional components/actuators and/or buses 11, 12, 13 having coupled thereon intelligent nodes 14 that have outputs for driving functional components/actuators 15. Thus, the fuse box 1 may in a conventional fashion have outputs 3 separately for each functional component/actuator of the vehicle. Additionally, the fuse box may have coupled thereto one or more buses 11-13 formed by current conductors complemented with data conductors over which information is transmitted using some standardized data transmission protocol (CAN, LIN or IWS). Herein, CAN (Controller Area Network) is a protocol conventionally used by automotive vehicle manufacturers. IWS (Intelligent Wiring System) is a simplified version of the CAN protocol adapted by the applicant. LIN is a

master/slave-type protocol. As to the fuse box 1, the above-mentioned buses 11-13 represent a single protected load, whose overcurrent trip level is determined by the summed nominal maximum current of the loads connected to a given cable bus. The overload current monitoring of the loads 15 coupled to the buses 11-13 is performed with the help of intelligent nodes 14.

The overcurrent trip functions are accomplished by means of solid-state switches 4 that are connected between vehicle's power supply 2 and the load outputs 3 or the bus outputs 11-13. In addition to conventional overcurrent trip functions, the switches 4 can be employed to accomplish a number of other flexible functions to be described in more detail later in the text.

The fuse box 1 also includes inputs 5 for receiving control messages steering the ON/OFF state of solid-state switch 4. These control messages are submitted, e.g., from the control levers of turn indicators and windshield wipers, light switches and the like control switches of the dashboard, as well as from the sensors of functional components/actuators.

The invention is characterized in that a microprocessor 6 is employed for controlling solid-state switches 4 on the basis of a memory-stored program utilizing the current limit values of configuration data 8. The configuration data include the limits of a normal current window for each one of outputs 3 or 11-13 and a trip limit that is substantially higher than the upper limit of the normal current window. If the load current falls below the lower limit of the normal current window, a fault alarm is issued to a display 9. Respectively, if the upper limit of the normal current window is exceeded, the current drive is temporarily cut off and, based on the configuration data 8, the program stored in memory 7 decides whether to continue or not driving the load. However, if the trip limit of output current is exceeded, the switch 4 is invariably set into the OFF state in order to cut off the drive current to the load.

The current monitoring functions for both the normal current window and the trip limit are based on measuring the voltage over the solid-state switch 4 and/or the load, whereby the measurement value is compared with a reference value of the respective memory-stored current limit in the configuration data. This comparison may be performed using, e.g., a control circuit described in international patent application WO 00/69043 that serves a dual function in eliminating voltage and current transients occurring at either drive turn-on or turn-off. As generally known, turning on the load drive switches 4 involves a rush current transient that now can be eliminated by virtue of the intelligent fuse box according to the invention. More specifically, proper control of the switch 4 makes it possible to inhibit a transient overcurrent peak or, alternatively, allow a short-duration overcurrent peak at a current-limited level without tripping the drive to the load at the instant the solid-state switch 4 is controlled from the OFF state to the ON state. As noted above, these current limits are predetermined with the help of the configuration data 8. An additional benefit of the invention is that the configuration data 8 are reprogrammable via a service interface 10.

The facility of controlling the switches 4 in a programmable manner according to the stored configuration data can be further utilized to implement dynamic fuse functions such that, e.g., permit given functional components/actuators and/or cable buses to be driven at a reduced current when the vehicle is parked stationary.

The measurement of the overall current load of the vehicle's multiplex power distribution system can be arranged to take place based on, e.g., the voltage drops over the switches inasmuch these signals are readily obtainable from the overcurrent monitoring of the solid-state switches 4.

The state, current and diagnostic data of the protective element serving as fuses can be stored in the system memory for later service needs and, respectively, the data can be transmitted to a display unit or remote service

terminal. An optional bidirectional RF link between the vehicle and a service site is also feasible based on the information stored in the intelligent fuse box.

In addition to the above-described benefits, the invention offers higher system security and reliability, as well as longer life of the vehicle's electronics and functional components/actuators by virtue of the smoother control of load drive power. Moreover, the EMC interference level is reduced.

The physical fuse box that houses the electronics circuitry accomplishing the above-described functions may be designed to have a similar size and dimensions as a conventional fuse box, whereby the adoption of the novel fuse box does not dictate a redesign of the vehicle's wiring system.

What is claimed is:

1. An intelligent fuse box (1) for a vehicle's multiplex power distribution system, the fuse box including outputs (3) for the vehicle's functional components/actuators and/or cable buses (11-13) equipped with intelligent nodes (14), the latter in turn having outputs for driving functional components/actuators (15), and further including means serving fuse functions between the outputs (3; 11-13) and the vehicle's power supply bus (12), **characterized** in that said fuse-function means are controlled solid-state switches (4) and that said fuse box (1) further includes inputs (5) for receiving messages controlling the ON/OFF state of solid-state switches (4) and a microprocessor (6), the latter controlling the solid-state switches (4) based on a program stored in the microprocessor memory (7) and on current limits predetermined in configuration data (8).

2. The fuse box of claim 1, **characterized** in that the current-limiting function of the same is made controllable based on comparing the voltage measured over said solid-state switch (4) and/or the load with a respective voltage value of the configuration data which are stored in the memory (8) and corresponds to the desired current limit.

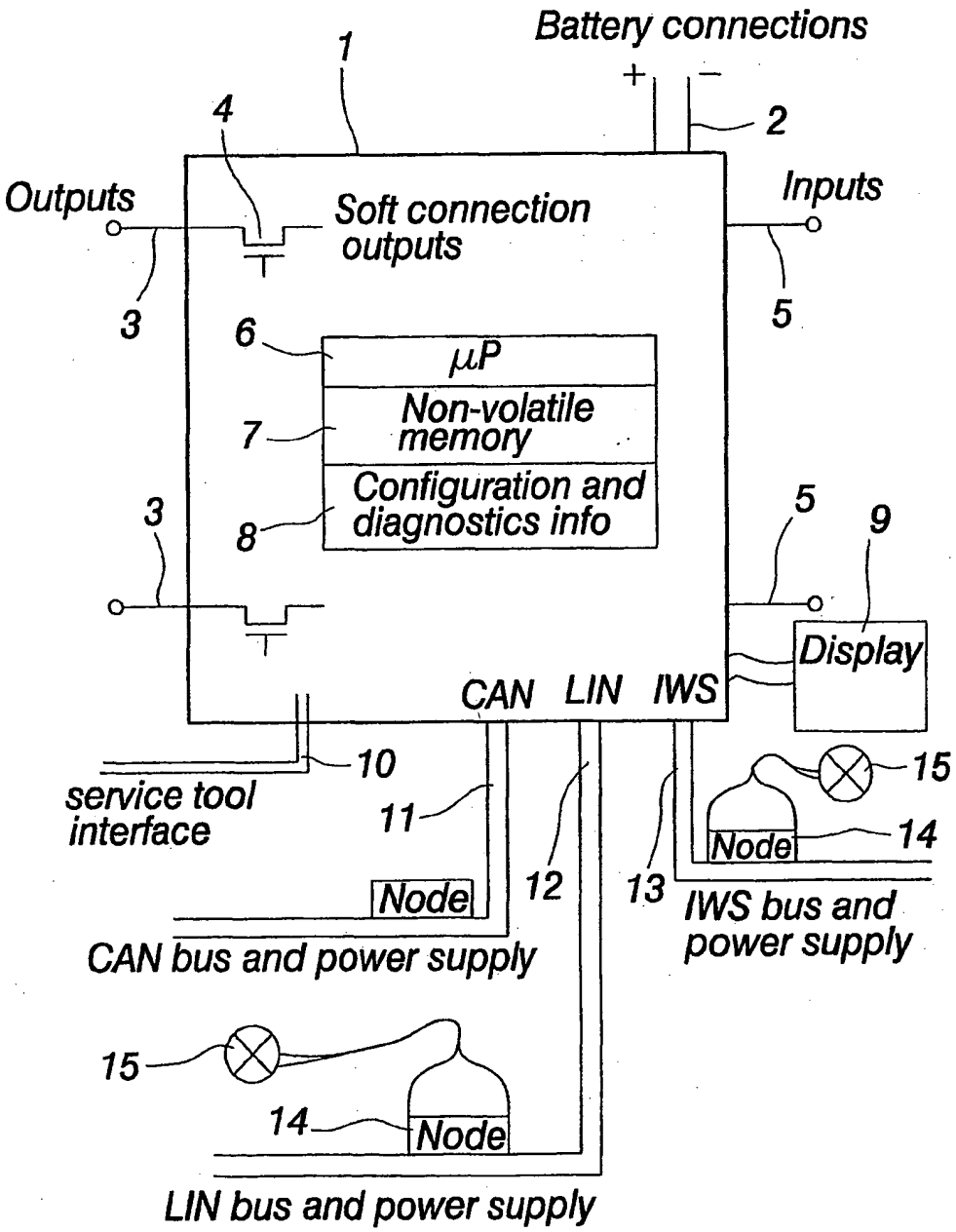
3. The fuse box of claim 1 or 2, **characterized** in that the turn-on control of said solid-state switches (4) is complemented with a current-limiting function known as "soft connection" that is capable of inhibiting a transient overcurrent peak or, alternatively, allowing a short-duration overcurrent peak at a current-limited level without tripping the drive to the load at the instant the solid-state switch (4) is controlled from the OFF state to the ON state.

4. The fuse box of any one of claims 1-3, **characterized** in that the configuration data (8) are reprogrammable via a service interface (10) for altering the predetermined current limits.

5. The fuse box of any one of claims 1-4, **characterized** in that the current limits include the limits of a normal current window with an lower limit and an upper limit, whereby violation of the lower limit triggers a fault message while violation of the upper limit causes the load current drive to be temporarily cut off for a time interval predetermined in the configuration data, and that in the configuration data is also stored a trip current limit which is substantially higher than the upper limit of the normal current window and at which the load current drive is permanently cut off.

6. The fuse box of any one of claims 1-5, **characterized** in that said solid-state switches (4) are controlled to drive given functional components/actuators and/or cable buses at a reduced current when the vehicle is parked stationary.

7. The fuse box of any one of claims 1-6, **characterized** in that the overall load current measurement of the vehicle's multiplex power distribution system is arranged to take place based on voltage drops over the solid-state switches that are sensed to control the switches in their fuse function.


Battery connections
+
−
1
2
4
Outputs
Soft connection outputs
Inputs
3
5
6
μP
7
Non-volatile memory
8
Configuration and diagnostics info
3
5
9
Display
CAN
LIN
IWS
10
service tool interface
11
Node
12
13
15
Node
14
IWS bus and power supply
CAN bus and power supply
15
14
Node
LIN bus and power supply

INTERNATIONAL SEARCH REPORT

International application No.
PCT/FI 01/01144

A. CLASSIFICATION OF SUBJECT MATTER

IPC7: B60R 16/02
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC7: B60R, H02J

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-INTERNAL, WPI DATA, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	EP 0812049 A1 (HITACHI, LTD), 10 December 1997 (10.12.97), page 1, line 39 - line 42; page 11, line 10 - page 12, line 50	1-7
Y	EP 0529650 A2 (YAZAKI CORPORATION), 3 March 1993 (03.03.93), column 7, line 3 - line 27, figure 6	1-7
Y	Patent Abstracts of Japan, abstract of JP 10-42481 A (HITACHI LTD HITACHI CAR ENG CO LTD), 13 February 1998 (13.02.98)	1-7
A	US 4575673 A (RINALDO R. TEDESCHI ET AL), 11 March 1986 (11.03.86), abstract	1-7

[X] Further documents are listed in the continuation of Box C. [X] See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
25 March 2002	04-04-2002
Name and mailing address of the ISA/ Swedish Patent Office Box 5055, S-102 42 STOCKHOLM Facsimile No. +46 8 666 02 86	Authorized officer Irma Bornhede/MN Telephone No. +46 8 782 25 00

Form PCT/ISA/210 (second sheet) (July 1998)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/FI 01/01144

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 6157091 A (TATSUYA YOSHIDA ET AL), 5 December 2000 (05.12.00), page 4, line 17 - line 41, figure 1, abstract -- --------	1-7

INTERNATIONAL SEARCH REPORT

Information on patent family members

28/01/02

International application No.
PCT/FI 01/01144

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP 0812049 A1	10/12/97	JP 62255347 A	07/11/87
		US 6182807 B	06/02/01
		EP 0728622 A	28/08/96
		JP 2001315593 A	13/11/01
		JP 2001328494 A	27/11/01
		US 6020811 A	01/02/00
		US 6243018 B	05/06/01
		US 2001028241 A	11/10/01
		WO 9626570 A	29/08/96
		US 5808371 A	15/09/98
		US 5917249 A	29/06/99
		US 6166453 A	26/12/00
EP 0529650 A2	03/03/93	DE 69228780 D,T	21/10/99
		JP 2695316 B	24/12/97
		JP 5058231 A	09/03/93
		KR 124373 B	01/12/97
		US 5675189 A	07/10/97
		JP 2661819 B	08/10/97
		JP 5064361 A	12/03/93
		JP 5152996 A	18/06/93
US 4575673 A	11/03/86	NONE	
US 6157091 A	05/12/00	DE 19725153 A	18/12/97
		JP 3234861 B	04/12/01
		JP 10004632 A	06/01/98
		US 5990570 A	23/11/99
		US 6163082 A	19/12/00
		US 6169337 B	02/01/01
		US 6294845 B	25/09/01
		US 6307279 B	23/10/01
		US 2001054847 A	27/12/01